(12) UK Patent Application (19) GB (11) 2 313 859 (13) A

(43) Date of A Publication 10.12.1997

(21) Application No 9606529.7

(22) Date of Filing 28.03.1996

(51) INT CL^6
E21B 29/12

(52) UK CL (Edition O)
E1F FLA

(56) Documents Cited
None

(58) Field of Search
UK CL (Edition O) E1F FLA
INT CL^6 E21B

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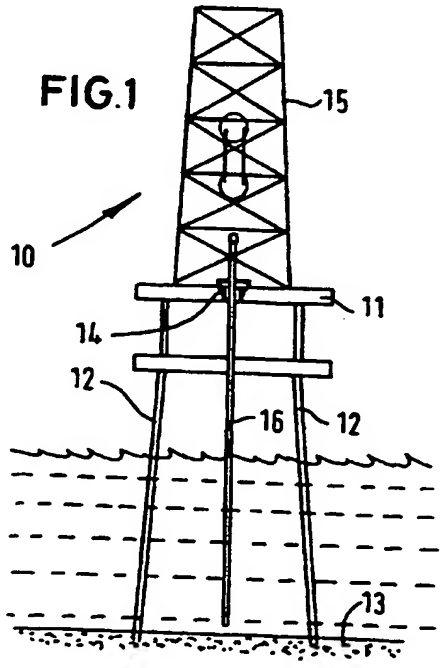
(54) Clearing sub-sea well risers

(57) A method of clearing a riser 16 of a sub-sea well following abandonment of the well comprises an initial step of separating the riser 16 from the downhole casings and strings, at or in the region of the mud line 13, and then repeatedly performing the steps of: (a) locking together the tubes comprising the riser 16, at a location below the deck 11 of a rig 10 above the well; (b) using the rig derrick 15 to lift the riser 16 through a height determined by the weight of riser above the deck 11; (c) clamping the riser at or below the deck 11 to prevent vertical downward movement of the riser; (d) using a guillotine (Figure 3) to sever the riser horizontally above the location whereat the tubes are locked together; and (e) removing the severed upper end portion of the riser from the derrick 15.

FIG.1



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

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FIG. 3

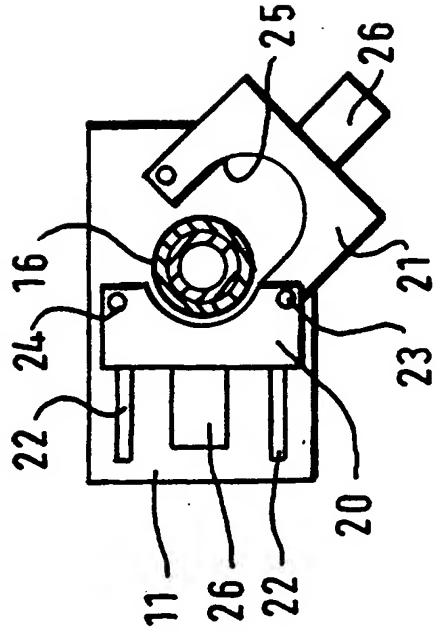
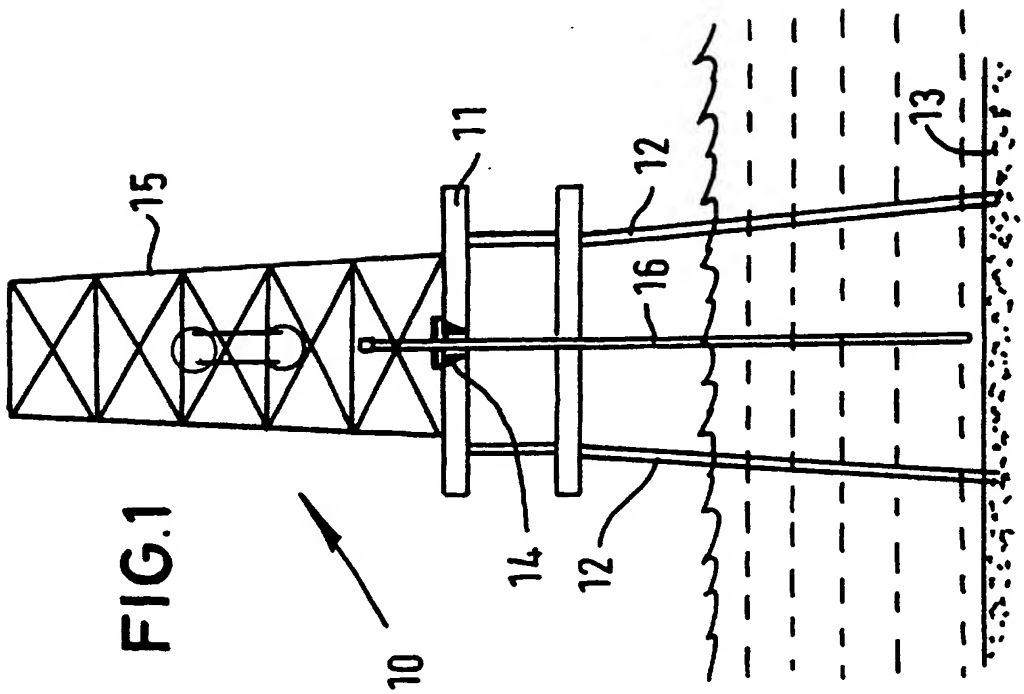


FIG.1



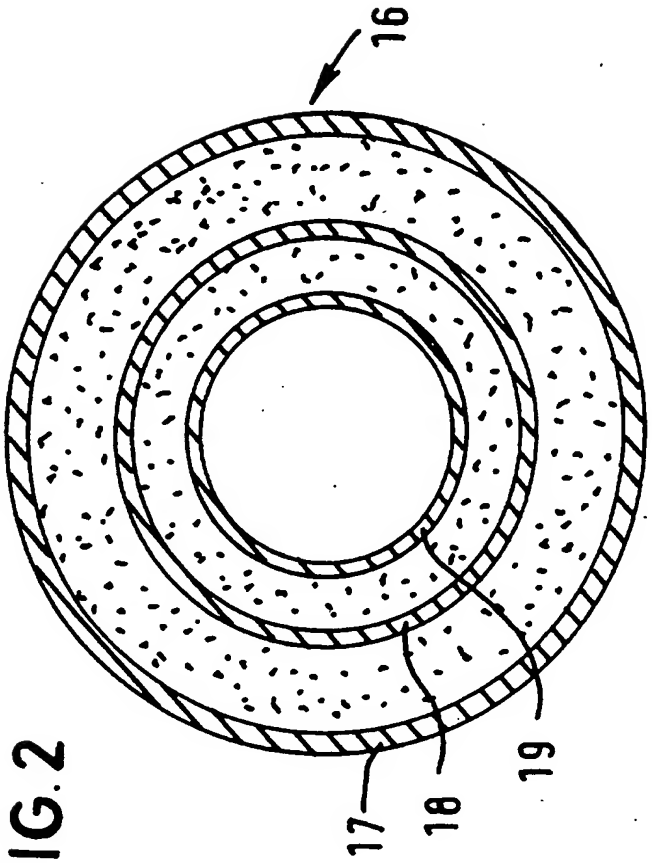


FIG.2

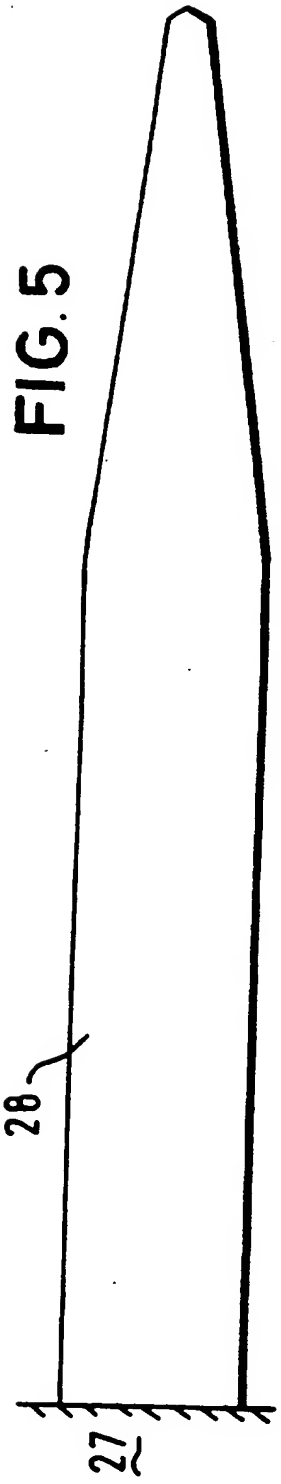


FIG.5

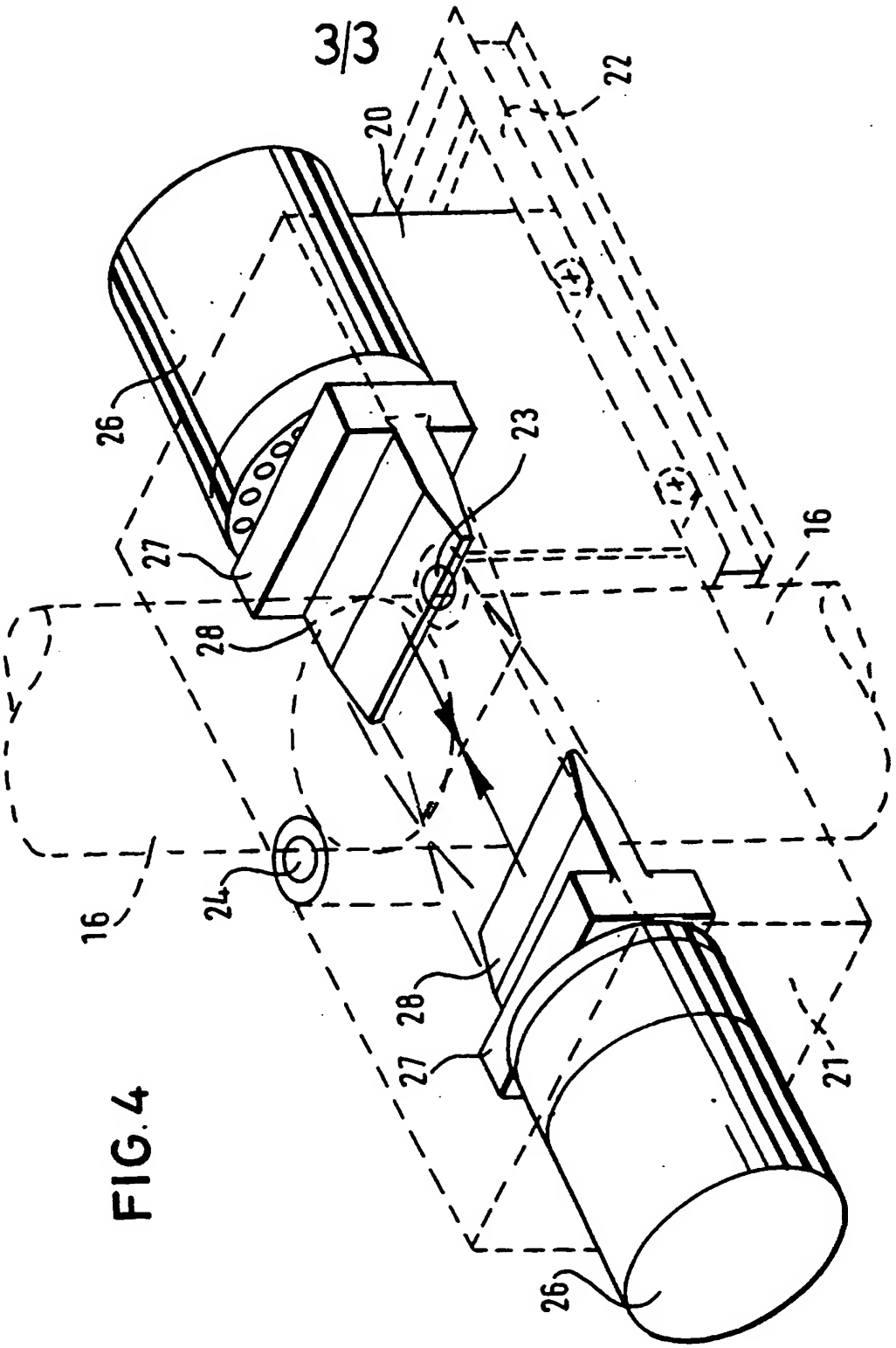


FIG.4

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CLEARING SUB-SEA WELL RISERS

This invention relates to a method of clearing a riser from a sub-sea well, and also to apparatus for use in performing such a method.

In the oil exploration and production industry, wells are frequently abandoned either because the well no longer can economically produce oil or gas, or because the well was drilled for exploratory purposes and is not required for commercial production. When a decision is taken finally to abandon a sub-sea well, it is necessary permanently to seal the well significantly below the mud line so as to prevent leakage from the well in the future. Also, government regulations require the removal of the riser, leading from the sea bed well head to the rig, and also the sea bed well head housing itself, so leaving the sea bed wholly unobstructed.

The sealing of the well is normally performed by cementing operations, in the course of which cement is injected under pressure in to the riser, so as to plug the well below the mud line. Once the cement has set, as confirmed by effecting pressure tests, the riser from the sea bed may be cut away from the well head or the casings may be cut away below the well head, so that the well head remains connected in to the string extending down from the rig. Then, the riser must be

cut in to manageable lengths, for transport away from the well site.

A typical riser from a sub-sea well may comprise a 30ins (about 762mm) environmental barrier, a 20ins (about 508mm) casing and a 13.625ins (about 346mm) intermediate casing, all arranged concentrically. During the course of the installation of the well, the length of the riser annuli, from the sea bed upwards, usually will be filled with cement. Consequently, a typical riser has a relatively high weight per unit length. A 40ft length (about 12m) of riser may weigh significantly in excess of 20t.

When a well is being finally abandoned, the well operator wishes to minimise the expense of abandonment. Consequently, the operator does not want to utilise more than the absolute minimum of additional equipment for disposing of the riser. Having regard to the relatively high weight per unit length of such a riser, it is the conventional practice to cut the riser in to typically 20ft to 40ft (about 6m to 12m) lengths by lifting the riser with the rig derrick through a suitable distance, clamping the riser at a deck of the rig against downward movement and then cutting through the part of the riser upstanding above that deck.

Though it is possible to cut through the riser using gas cutting tools or thermic lances, such a procedure is very slow to perform. Consequently, there

has been developed a kind of horizontally-acting band-saw, but even this takes at least one hour to cut through a typical riser and in view of the number of cuts which may have to be made, the procedure for removing the riser becomes most protracted. Moreover, there are significant risks associated with the use of a band-saw, since the saw blade has a limited life and is prone to breakage.

It is a principal aim of the present invention to provide a method and apparatus whereby a riser may be removed from an abandoned sub-sea well, in a relatively safe and economic manner, as compared to the above-described conventional procedures.

According to one aspect of the present invention, there is provided a method of clearing a riser of a sub-sea well following the abandonment thereof, which well has a rig furnished thereover, comprising the step of separating the riser from the downhole casings and strings, at or in the region of the mud-line, and then repeatedly performing the steps of:

locking together the tubes comprising the riser, at a location below a deck of the rig;

using the rig derrick to lift the riser through a height determined from the weight of riser above said deck;

clamping the riser at or below said deck, against vertical downward movement;

using a guillotine having a pair of co-operating cutting blades acting in opposition to sever substantially horizontally through the riser, above the location of the locking together of the tubes comprising the riser; and

removing the severed upper end portion of the riser from the derrick.

It will be appreciated that in the method of the present invention, an upper end portion of the riser is severed from the remainder of the riser by means of a guillotine having a pair of co-operating cutting blades, between which is located the riser. Calculations have shown that it is possible to construct a guillotine to have sufficient strength and cutting power to be able to cut through the concentric steel tubes comprising the riser, together with any concrete or cement located at least in the annuli of the riser. Such a guillotine of necessity must be capable of exerting very high forces in order to cut through the riser but provided the guillotine is designed to have a sufficient capacity, the cutting of the riser may be performed in a clean and rapid manner, with a high degree of safety.

The separation of the riser from the various downhole casings and tubes may be performed by an explosive cutting charge positioned at, or a little below, the mud-line. Such an explosive charge is

conventionally employed for this purpose, either to separate a riser from any tubes and casings left downhole when a well is abandoned, or to separate a sea bed well head from those downhole tubes and casings.

It is an essential step of this invention that the tubes within the outermost tube of the riser are locked to the outermost tube at a position below the location where the cut is to be performed. This is because the lifting of the riser is performed from a position adjacent the free upper end of the riser, with the clamping of the riser being performed solely on the outermost tube, below the location of the cut. By locking together all of the tubes of the riser, below the position of the cut, all of the remaining lengths of riser tubes will be prevented from dropping downwardly at the completion of the cut. The clamping of the riser may be performed in an essentially conventional manner commonly employed in the well-drilling art. For example, a clamp ring may be fitted to the riser above a rotary table of the rig, and slip wedges may be located between that clamp ring and the rotary table.

Conveniently, the tubes of the riser are locked together by forming a hole substantially diametrically through the riser and inserting a steel pin through that hole. For a riser with a 30ins (about 762mm) outer tube, the pin may typically be 100mm diameter.

Lifting of the riser may be performed by engaging an internal spear, known per se in the drilling art, in the innermost tube of the riser, and then lifting the spear with the rig derrick. As all the tubes of the riser are locked together, all those tubes will be lifted at the same time. The length of the end portion cut off should be determined from a consideration of the expected overall weight of length per riser, in order that the cut off portion may easily be handled using equipment already present on the rig.

According to a second aspect of the present invention, there is provided a guillotine for use in a method of this invention as described above, which guillotine has a body formed in two parts which together define an aperture for receiving the riser, the two parts meeting on an axial plane of the aperture and being arranged such that the two parts may be relatively separated to permit the location of the body about a riser.

Preferably, the two parts of the guillotine are hinged together on one side of the aperture, and means are provided for locking together the two parts, on the other side of the aperture. In this way, the guillotine may surround the riser which extends through the aperture in the body, with the two parts then locked together to permit a severing operation. Each body part preferably carries a respective cutting blade

and a respective hydraulic ram arranged to effect sliding movement of the associated blade, towards and away from each other.

The body of the guillotine may be mounted on a carriage which is adapted for sliding or rolling movement on a deck of the rig. In this way, once the two body parts have been separated, the guillotine may be moved away from the riser to give access to the rotary table and other components in the vicinity of the riser.

By way of example only, one specific clearing method and embodiment of guillotine both according to the present invention will now be described in detail, reference being made to the accompanying drawings in which:-

Figure 1 is a diagrammatic side-view of an offshore drilling rig together with a riser;

Figure 2 is a horizontal section through the riser;

Figure 3 is a plan view on a guillotine employed to sever the riser;

Figure 4 is a diagrammatic perspective view of the guillotine; and

Figure 5 is a detail view on one guillotine cutting blade.

Referring initially to Figure 1, there is shown a rig 10 comprising a platform 11 standing on legs 12 located on the sea bed 13. A rotary table 14 is fitted

in the platform 11 and a derrick 15 upstands from the platform, centrally over the table 14. A riser 16 normally leads up from a well head at the sea bed 13, when the well is in production, but following abandonment of the well, the riser must be removed from the sea bed, as must any sea bed well head so that the sea bed is wholly unobstructed at the completion of the abandonment operation.

Figure 2 is a cross-section through riser 16. The precise configuration of the riser may vary from well to well, but typically comprises a 30ins (about 762mm) environmental barrier 17, a 20ins (about 508mm) casing 18 and a 13.625ins (about 346mm) intermediate casing 19, all arranged concentrically. At the time of abandonment, any other strings located within the intermediate casing will have been withdrawn and the well will have been plugged by cementing operations, below the sea bed. An alternative riser configuration may comprise a 26ins (about 660mm) environmental barrier, a 18.635ins (about 473mm) casing and a 13.625ins (about 346mm) intermediate casing. During installation of the well, the two annuli between the environmental barrier 17 and the intermediate casing 19 will have been filled with loose concrete or other cementitious material, which will of course still be present at the time the riser is to be cleared.

Figures 3 and 4 show a guillotine adapted for

positioning on the platform 11 of the rig, for cutting through the riser. The guillotine comprises two body parts 20 and 21, body part 20 being mounted on a wheeled carriage running on two support rails 22. The support rails are furnished on the platform 11, generally radially of the riser.

Body part 21 is hinged at 23 to body part 21, and a pin 24 may be dropped through a corresponding hinge on the opposite side of the body. Each body part defines a portion of a generally-circular aperture 25, through which the riser 16 may extend, as illustrated in Figure 3.

Each body part carries the cylinder 26 of a respective hydraulic ram, the piston rod of each ram having a platen 27 mounted on its free end and carrying a cutter blade 28, shown in more detail in Figure 5. When the two body parts are locked together as shown in Figure 4, the two cutting blades 28 are opposed to each other and operation of the rams will move the two cutting blades together, so severing a riser located therebetween.

The clearing of a riser 16 is performed by the repetitive operation of the following steps, presuming the riser has already been freed at the sea bed:

1. The tubes 17,18,19 of the riser are locked together below the platform 11, by forming a horizontal diametral hole through the riser and inserting a pin

through that hole. Conveniently, this operation is performed at a deck 30 below platform 11.

2. A spear suspended from the derrick 15 is inserted into the free upper end of the riser and engaged with the intermediate casing 19. The derrick is then operated to lift the entire length of the riser through a suitable distance - and typically by 7m to 10m.

3. A clamp ring is fitting round the riser and slips inserted between the clamp ring and the rotary table, so as to hold the riser against descent.

4. The guillotine is moved on rails 22 to the riser and the two body parts are closed therearound. The hydraulic rams are operated so that the blades 28 cut through the riser.

5. The free end portion of the riser, suspended from the derrick 15, is cleared away from the derrick, and typically is craned on to an alongside ship.

By performing the above steps, a riser - which typically may be 200ft to 800ft (about 61m to 245m) - may be cut into manageable sections each weighing about 20t and be loaded on to a ship, for removal from the well site.

CLAIMS

1. A method of clearing a riser of a sub-sea well following the abandonment thereof, which well has a rig furnished thereover, comprising the step of:

- separating the riser from the downhole casings and strings, at or in the region of the mud-line; and then repeatedly performing the steps of:

- locking together the tubes comprising the riser, at a location below a deck of the rig;

- using the rig derrick to lift the riser through a height determined from the weight of riser above said deck;

- clamping the riser at or below said deck, against vertical downward movement;

- using a guillotine having a pair of co-operating cutting blades acting in opposition to sever substantially horizontally through the riser, above the location of the locking together of the tubes comprising the riser;

- removing the severed upper end portion of the riser from the derrick.

2. A method as claimed in claim 1, wherein the separation of the riser from the downhole casings and strings is performed by an explosive cutting charge positioned at or in the region of the mud-line.

3. A method as claimed in claim 1 or claim 2, wherein the locking together of the tubes comprising

the riser is performed by forming a substantially horizontal hole diametrically through the riser and fitting into said hole a locking pin.

4. A method as claimed in any of the preceding claims, wherein the riser is clamped to the rotary table of the rig.

5. A method as claimed in claim 4, wherein a clamp ring is fitted to the riser, which clamp ring co-operates with slip wedges fitted below the clamp ring, between the riser and the rotary table.

6. A method as claimed in any of the preceding claims, wherein the guillotine has a body which is fitted around the riser, the body slidably mounting a pair of opposed cutting blades each of which is provided with respective hydraulic actuating ram.

7. A method as claimed in claim 6, wherein the body of the guillotine defines an aperture for receiving the riser and is split about an axial plane of the aperture whereby the body may be opened to permit the location of the body about a riser.

8. A method as claimed in any of the preceding claims, wherein the riser is lifted by engaging a spear with the inner tube of the riser, and then raising the spear by means of the derrick.

9. A method of clearing a riser of a sub-sea well following the abandonment thereof and substantially as hereinbefore described with reference to the

accompanying drawings.

10. A guillotine for use in a method according to any of the preceding claims, which guillotine has a body formed in two parts which together define an aperture for receiving the riser, the two parts meeting on an axial plane of the aperture and being arranged such that the two parts may be relatively separated to permit the location of the body about a riser.

11. A guillotine as claimed in claim 10, wherein the two parts of the body are hinged together on one side of the aperture.

12. A guillotine as claimed in claim 10 or claim 11, wherein each body part carries a respective cutting blade and a respective hydraulic ram arranged to effect sliding movement of the associated blade.

13. A guillotine as claimed in any of claims 10 to 12, wherein the body is mounted on a carriage, which carriage is adapted for sliding movement on the deck of a rig.

14. A guillotine as claimed in claim 10 and substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

The Patent Office

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Application No: GB 9606529.7
Claims searched: 1 to 9

Examiner: David Harrison
Date of search: 19 June 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): E1F (FLA)

Int Cl (Ed.6): E21B

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
	NONE	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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